Promoting Public Transportation for Sustainable Development

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I pledge my honor that I have not violated the honor code in writing this paper.

ABSTRACT

This policy proposal will address the issue of public transportation as a means for sustainable development. Transportation is an issue that needs to be addressed because it has two deleterious effects on the environment. One is the effect of vehicle carbon dioxide, CO_2, emissions on climate change and the second stems from other vehicle emissions that cause air pollution leading to negative health effects. These two issues warrant the conclusion that transportation needs to be monitored. Policies can be instituted to mitigate these negative consequences. This report will focus its policy recommendations on promoting public transportation as a means for environmental sustainability. The idea is that increased use of public transportation will lessen the demand for private transportation thereby lowering the number of vehicles on the road and thus lessening global vehicle emissions.

INTRODUCTION

Addressing issues of sustainability allows societies to meet their present needs without compromising the environment for future generations. This policy proposal will address the promotion of public transportation systems as a means for sustainable development. A more sustainable approach to transportation will lead to less environmental damage before it occurs rather than as a reaction to the damage that results from vehicle emissions (Fergusson and Skinner, 1999). There are two important aspects of environmental damage: the first is CO_2 emissions that cause climate change and the second is other emissions that contribute to air pollution and subsequent health effects.

These two problems are exacerbated by the increasing trend for private vehicles. The trend calls for more vehicles on the road which means more vehicle emissions and thus more

deleterious environmental effects. If public transportation is used more frequently, this can serve as a way to reduce the number of vehicles on the road and subsequently reduce emissions (Uhl and Anderson, 2001).

Specifically, this report will analyze the United States' transportation systems. Trends in the US transportation sector tend to be 20 years ahead of those in other industrialized countries. In turn, the carbon emissions from the US transportation sector amount to 5% of the global carbon emissions. That amounts to more than those of any other sector in any other country. In fact, the US automotive industry is a key player in the world market and thus is in a good position to initiate change and become a model of best practice (Hardin, 2002).

In addition, an analysis of the public transportation systems in the developing countries, with specific examples from China and India, will be presented. These are important countries to address because they have risen as global economic powers with overwhelmingly large populations. These nations have expanding middle classes with growing needs for better housing, more consumer goods, and better transportation (Lehman, 2005).

China is particularly important because it is a major source of urban air pollution world wide (Zhao et al, 2004). In fact, China is currently the world's second-leading emitter of carbon dioxide and other greenhouse gases (described below) which contribute to global climate change. It is projected to surpass the US and become the world's top emitter by 2020 (Esty and Dunn, 1997). India's CO_2 emissions account for only 2-4% of the world's total but are important to address because India is a country rapidly expanding beyond a billion people who have increasing demands for transportation (Tiwari, 2003). Although per capita CO_2 emissions in India are below a quarter of the world average, the national growth rate exceeds

the global rate, which ultimately means an increasing global share of emissions (Tiwari, 2003).

This paper will first discuss how vehicle emissions present an environmental problem. Next the paper will review the current situations in the US and in the developing countries, China and India. The paper will end with policy recommendations aimed at making transportation more sustainable through decreasing vehicle emissions by lowering the trend for personal vehicle travel and replacing this with public transit. Policy recommendations for reaching this goal involve improving current public transportation systems, encouraging the use of public transportation systems, discouraging the use of private vehicles, and changing urban plans and city designs.

THE PROBLEM

Vehicle emissions have two negative effects on the environment: one is global climate change and the other is air pollution and its negative health repercussions. With the increasingly mobile population in the United States and greater numbers of middle class and wealthy individuals in developing countries who can afford private vehicles, these problems are worsening (Tiwari, 2003). Driving one's own car is often considered a benefit of economic success but due to increasingly adverse environmental and health effects related to vehicle emissions, universal car ownership is an issue that can no longer be ignored (Tiwari, 2003).

Climate change is a result of increasing carbon dioxide, CO_2, emissions. The climate change of concern is increasing global temperatures that are attributed to the "greenhouse" effect. The greenhouse effect results from carbon dioxide, the most important of the

greenhouse gases[1], which acts like a blanket around the earth, keeping surface temperatures at warm levels. Increasing the CO_2 concentration in the earth's atmosphere effectively adds another blanket which warms the Earth's surface even more (Hare, 1997).

As a result of this warming, world temperatures have risen by about 0.5 degrees Celsius in the past century (Hare, 1997). If the trend of increasing CO_2 emissions continues, scientists project that the global temperature will increase by 3 degrees Celsius in the next century (some US agencies assume an even higher increase of 4-5 degrees Celsius; Suess, 1993). The results of this temperature increase would also mean a global average increase in sea-level of 0.66 m due to melting of the polar icecaps, causing a loss of some coastal areas. There may also be desertification – the conversion of formerly productive land to desert- in some areas which would contribute to poverty, famine, and food insecurity (Cunningham et al, 2006; Suess, 1993).

It is estimated that approximately 50% of these effects are caused by CO_2. More importantly, about 20% of CO_2 emissions in the US come from motor vehicles. In the developing countries too, increasing modernization has led to an increased presence of motor vehicles which means a large percentage of CO_2 emissions in these countries comes from motor vehicles as well (Harrington and McConnell, 2003). Thus, in order to control climate change, the issue of vehicle CO_2 emissions needs to be addressed.

In addition to CO_2 emissions and the resulting climate change, other vehicle emissions contribute to air pollution. Vehicles account for most of the carbon monoxide (CO) and a large share of the hydrocarbons (HC), nitrogen oxides (NOx), and particulates found in the atmosphere in major urban areas. Nitrogen oxide (NO) results when nitrogen in the fuel or in the combustion of air heats to temperatures above 1,200 degrees Fahrenheit in the presence of

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[1] Other greenhouse gases include water vapor, methane, and nitrous oxide (Cunningham et al, 2006).

oxygen. This reaction occurs in most car engines today. Nitric oxide (NO) is the initial

product and oxidizes to nitrogen dioxide (NO_2). Nitrogen oxides also combine with water

leading to a component of atmospheric acidification, specifically nitric acid (HNO_3). In turn,

this leads to "acid" rain. The general term "NOx" is used to describe this family of emissions

(Cunningham et al, 2006). Vehicle emissions constitute the greatest individual source of

nitrogen oxides in industrialized courtiers (Suess, 1993). Table 1 below shows the

contribution of vehicle emissions to pollution in the atmosphere and their resultant effects.

Table 1: Air Pollution from Motor Vehicles (Federal Highway Administration, 2002;
Harrington and McConnell, 2003)

Air Pollutant	Proportion from On-Road Motor Vehicles in US	Effects
Hydrocarbons	48%	Antecedent to ground-level ozone (smog)
Oxides of Nitrogen (NOx)	43%	Antecedent to ground-level ozone (smog)
Carbon Monoxide (CO)	66%	Contributes to smog production, poisonous in high concentrations
Particulate Matter (PM_{10})	10%	Health problems when passing through the throat, nose, and entering lungs

It is clear that much of these air pollutants in the US are due to vehicle emissions. More

importantly, these air pollutants have deleterious health effects. Particulate emissions

specifically are linked to increased risks of asthma, heart attacks, and reduced lung function

(Simms, 2004).

It is important to note too, that not only has air pollution reached critical levels in the

US, but it has in other developing countries as well. In fact, the pollution in these other places

may be worse. Table 2 below compares the air pollution in main cities in the US, China, and

India.

Table 2: Air Pollution Indicators in Mega-Cities in US, China, and India (Gan, 2003; The World Bank, 2001)

City	Population (millions, 2000)	Total Suspended particulates ($\mu g/m^3$, 1995)	Sulfur Dioxide ($\mu g/m^3$, 1998)	Nitrogen Dioxide ($\mu g/m^3$, 1998)
New York	16.6	61	26	79
Los Angeles	13.1	49	9	74
Beijing	10.8	377	90	122
Shanghai	12.9	246	53	73
Guangzhou	3.9	295	57	136
Delhi	11.7	415	24	41
Mumbai	18.0	240	33	39
Calcutta	12.9	375	49	34

Thus for example, China's and India's big cities are affected by air pollution problems caused by high levels of total suspended particulates, sulfur dioxide, and nitrogen dioxide. It is exhaust pollution from vehicle emissions that has increasingly become the source of air pollution in these cities (Gan, 2004). Clearly, there is increasing concern at the local, national, and global levels about the adverse environmental and health effects of air pollution directly attributable to transportation. It is apparent that transportation's impact on the environment needs to be addressed; transportation needs to become more sustainable (Fergusson and Skinner, 1999).

There are several ways to make transportation more environmentally sustainable. One strategy implemented by car manufacturers in the US involves increasing fuel efficiency through the corporate average fuel economy (CAFE). CAFE standards set an average gas mileage requirement for a car manufacturer's fleet, rather than for individual cars. The fuel economy of all the cars sold by a manufacturer in any given year must average 27.5 miles/gallon and the fuel economy of all light trucks sold must average 20.7 miles/gallon. However, many opponents to this approach offer that in the absence of higher gasoline prices,

improved fuel economy encourages people to drive an extra 10-20% more miles than they otherwise would, thus potentially negating the positive impact of the increased fuel efficiency (Holzman, 2005).

Whether or not the CAFE standards work however is not the issue here. It is more important to focus upon the ongoing problem created by the many high polluting vehicles still on the roads and the trend for increased private vehicles use that that comes with the increasing wealth of the US and developing countries (Harrington and McConnell, 2003). With affluence, people develop preferences for lifestyles that tend to center around an increased use of personal vehicles even if public transportation systems exist. This lifestyle preference leads to an increase in the negative environmental effects previously discussed (Gan, 2003).

It is clear then, that climate change and air pollution are issues that need to be addressed in order to move cities and regions towards a more sustainable existence. More public transportation use will mean fewer vehicles on the road, which will mean fewer emissions and less negative effects on climate and health. Society needs to act now to promote public transportation in order to save our environment from further climate change and to avoid the serious health effects of air pollutants.

TYPES OF PUBLIC TRANSPORTATION

General public transportation falls into the category of Mass Rapid Transit (MRT), or modes of urban transportation that carry large volumes of passengers quickly. MRT can be further subdivided into two categories: road based and rail based transportation. The categorization of transportation systems can be further broken down into five different types

of transportation (including bus, tramway, light rapid transit, metro, and rail, discussed below) that encompass the MRT system (Fouracre et al, 2002).

The first type of public transit involves buses that use dedicated rights of way (ROW), such as bus lanes or bus ways. Effective bus way transit features high passenger capacity, efficient fee collection methods, well-designed bus stops, organized operations, and handicap accessibility. Bus way transit provides good services at a reasonable cost but often falls victim to stigmatization as a negative, unsafe travel modality. People find bus transit to be dirty, slow, noisy, and a generally poor quality ride meant to serve low-income residents without cars (Hardin, 2002).

The second type of MRT system is tramways, which are light, electrically powered cars that travel paths that may be completely or partially shared with other traffic. The third type of MRT system is known as Light Rapid Transit (LRT). It employs a fully segregated travel path and advanced control systems. The trains are light, like modern tramcars, and are often seen as intermediates between metro and bus systems in terms of cost and capacity (Fouracre et al, 2003).

The fourth type of MRT is metros. Metros feature fully segregated and grade-separated tracks and may be underground or elevated. These metros, also known as trains (or subways), are made up of heavy cars and can provide the highest levels of service - in terms of frequency and speed - but are also the most expensive. In addition, metros can carry the greatest numbers of passengers over any other public transportation system. The final type of MRT is suburban rail which transports passengers from suburban to urban areas. This system tends to exist as a larger rail network often separated from road traffic. It functions in the

context of a wider network demand and is characterized by higher headways and longer station spacing (Fouracre et al, 2003).

EXISTING PUBLIC TRANSPORTATION

United States

The vast majority of people in the US use private transportation mechanisms for commuting. In fact, public transit systems only serve 1% of the transportation demand in this country (Lee, 2000). Several factors account for this observation. First, many locations nationwide simply lack public transportation systems. Additionally, in the locations where public transportation systems do exist, they may be inadequate and in need of improvements and enhancements.

Furthermore, in many cases, if US citizens can afford private transportation, they choose to use it. In fact, because time has become such a valued commodity in our current society, many people shift towards more convenient methods for commuting to work in order to match their own unique needs. This time factor has the effect of moving people from public transportation and car pooling to private vehicle use (Robinson, 2004).

Private vehicle use is regarded as more convenient and appealing in contrast to the highly stigmatized reputation that public transportation holds in society. Many people view public transit as unreliable, unattractive, unclean, and not worth the wait (Hardin, 2002; Lee, 2000). Travelers prefer the independence and flexibility of their personal automobile. As evidence of this, a Federal Highway Administration study found that in 1960, 69% of workers nationwide (41 million workers) used private vehicles to commute to work and in 2000, this number had increased to 88% (113 million workers; McGuckin and Srinivasan, 2003). In

addition, the percentage of overall workers who used mass transit dropped from 6.2% to 5.3% from 1980 to 2000 (McGuckin and Srinivasan, 2003).

The cities that do have public transportation systems tend to be those that have highly developed expertise in urban control and management. This is due to the fact that transit mechanisms require a high degree of operational integrity as a prerequisite for their successful implementation and use (Fouracre et al, 2003). Places like Chicago, New York, San Francisco, Philadelphia, Washington, Cleveland, Miami, Buffalo, Baltimore, and Atlanta satisfy these requirements.

New York serves as a good example of public transportation in the US. With 230 miles of track, New York accounts for the bulk of US subway travel. Subways have minimal operating costs and are the most energy-efficient form of public transportation. Compared to bus transportation which requires one driver for about 50 people, one New York subway conductor can transport about 1,400 people (Schumer, 1980).

Chicago serves as another good example of the public transportation in this country. The Chicago Transit Authority (CTA) operates the second largest public transit system in the United States and serves the city of Chicago and its 38 surrounding suburbs. The CTA provides 1.5 million rides on an average weekday. This includes 560,000 trips to work (Welch et al, 2005). In addition to New York and Chicago, other cities, such as Atlanta, have large public transportation systems (Holsendolph, 1981). In Atlanta, 45% of all trips to work are taken by mass transit (Salisbury, 1982).

While it is true that public transportation systems do exist in some locations in the US, the systems are by no means adequate. Thus, the public transportation demand is not being met by the current infrastructure (Tumlin et al, 2003).

Developing Countries

The investment needed for the development of public transportation systems varies worldwide depending on location and the existent transportation infrastructure. In fact, the current level of investment in transportation is lower in developing counties than in the rest of the world. The figure below indicates the numbers of rail based systems used in the developing countries compared to other countries (Fouracre et al, 2003).
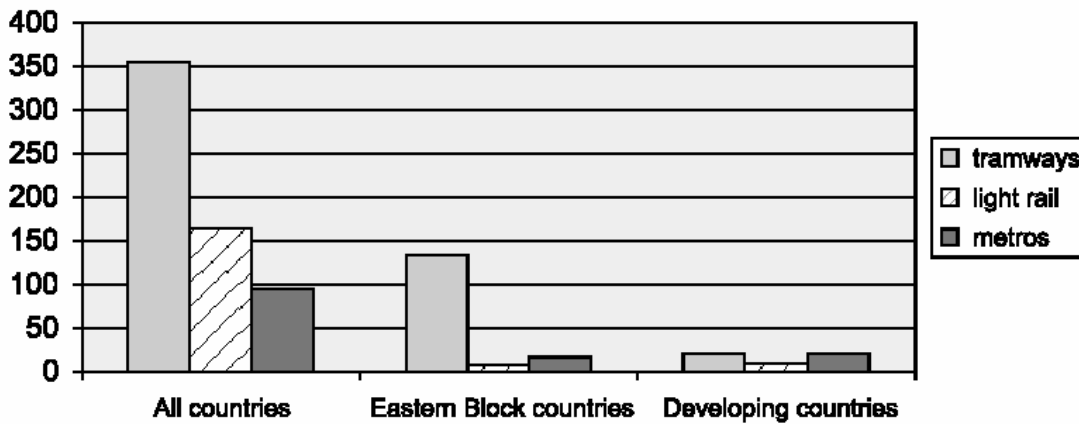

Figure 1.   Numbers of urban rail-based systems by location. Source: LRTA (2001).

Despite a significant proportion of the world's population residing in developing countries, especially in China and India, these countries currently have the smallest numbers of urban rail-based systems as shown in the graph. Although a similar graph of bus way transit and suburban rail systems is not available, it is known that suburban rail systems are used in large, developing cities such as Mumbai (Bombay), Madras, Calcutta, and Colombo. However, the trend is that the suburban systems in the developing cities do no meet commuter demands (Fouracre et al, 2003). To be more specific, the current public transportation systems in China and India will be reviewed.

China

The current transportation system in China has been growing in response to the economic demands and the increased standard of living in that country. There is an increased demand for quality, convenient, and flexible transportation (Gan, 2003). Further, much like the trend in developing countries, the wealthy and middle class citizens in China prefer private car use (Gan, 2003). In response to these changing trends, China is building its transportation infrastructure with a high dependency for on-road transportation and extensive use of automobiles. This has led to traffic congestion and environmental problems (Phipott, 1995). In certain locations, like Guangzhou, as of 1998, less than 18% of Guangzhou citizens use public transportation for commuting. The majority of citizens (42%) commute on foot and 22% commute on bicycle (Zhao et al, 2004).

Despite these compelling statistics, there are some useful public transportation systems in China worth noting. For example, there is an impressive magnetic-levitation rail link in China that uses powerful magnetic fields to elevate trains above tracks. It operates between Shanghai and that port city's main international airport. This 820 mile rail line is designed for speeds reaching a maximum of 220 miles/hr. Additional work will begin at the end of 2006 aimed at extending the line from Shanghai to Hangzhou (Wall Street Journal, 2006).

India

The current transportation system in India displays a similar trend to that of China: the increased living standard has led to an increased demand for quality transportation that is both convenient and flexible in nature (Gan, 2003). In this regard, wealthy citizens and the middle class prefer private car use. Table 3 below shows the estimated shares of transportation modalities in Delhi stratified by income category.

Table 3: Estimated Shares of Transport Modes in Delhi in 1999 (Tiwari, 2003)

Mode	Low-income (% population)	High-income (% population)	% Total Population
Cycles	39	3	24
Buses	31	36	33
Scooter/Motorcycles	3	29	14
Walking	22	2	14
Cars	0	28	12
Rail	1	0	1
3 wheel scootertaxis	1	2	1
Other Vehicles	3	0	1

The table reveals that scooter/motorcycles, walking, and cars each contribute a similar percentage to the total population's transport modes. However, use of cars and scooter/motorcycles results almost exclusively from high income citizens while walking is the transport mode mainly of low income citizens. Additionally, the data also reveal that the rail system in Delhi is not widespread because only 1% of the total population uses rail. Finally, the bus system seems to be the most effective form of public transit in Delhi; it is the category with the highest percentage of the total population's use, amounting to 33%. Even among citizens in the high income category, buses are used more than cars - 36% compared to 28%, respectively.

Like Delhi, citizens of Mumbai frequently use their bus system. This, along with the suburban rail system, functions as the most used types of transportation in Mumbai. These two public transportation systems carry about 86% of commuter trips (Larkin, 2006). Walking, biking, private motorized vehicles, auto-rickshaw, and taxis are also used but mainly to access the rail transit stations and bus stops in the city (Rastogi and Rao, 2003).

A successful public transportation system is also in place in Calcutta, India where there exists a 17 km metro. It took 22 years to build and remains state of the art in quality. It is

quite impressive, marked by its speed, punctuality, cleanliness, and use of tokens and smart cards at the ticket barriers (Perry, 2006).

China and India

However, similar to the United States' lack of public transportation in all locations nationwide, the systems in Shanghai, Delhi, Mumbai, and Calcutta are not matched in other urban locales throughout China and India (Fouracre et al, 2003). Public transportation in these developing countries is certainly non-ubiquitous in nature (Badami, 2003; Larkin, 2006). The current public transportation systems are not able to meet the increasing demand for commuter transport that comes with China's and India's rapid urbanization. This factor, coupled with the increase in the number of wealthy people who can afford private vehicles, has led to an increase in the number of private vehicles in these countries. Table 4 below shows data reflecting this increase in vehicles.

Table 4: Per Capita Vehicle Ownership (vehicles per 1000 population) (Energy Information Administration, 2001)[2]

	History (estimates)			Projections				% annual change
	1990	1998	1999	2005	2010	2015	2020	1990-2020
US	765	775	777	787	792	795	797	0.1
China	5	11	12	18	27	40	50	7.5
India	5	9	10	15	22	33	44	7.6

It is clear from the above table that the United States has significant per capita vehicle ownership with more than three quarters owning cars (>750 per 1000 population). The per capita vehicle ownership in the developing countries is significantly smaller. India, for example, falls in the bottom 10 countries with few per capita motor vehicles owed per 1000 people. The only countries (for which data are available) that have less are Pakistan,

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[2] Totals may not equal sum of components due to independent rounding.

Cambodia, Uganda, Ethiopia, and Bangladesh (International Band for Reconstruction and Development, 2004). In 1999, only 1.2% and 1% of the population in China and India, respectively, had their own vehicles whereas 78% of the US population had their own vehicles. However, the projected annual growth rate in per capita vehicle ownership over the next decade and a half for China and India is significant at 7.5% and 7.6%, respectively. With public transportation systems requiring remedial efforts in these countries, citizens of high incomes are increasingly turning to the convenience and comfort of private vehicles. Furthermore, since these two countries have a significant proportion of the world's population, these increases represent a significant number of additional vehicles overall (Gan, 2003; Tiwari, 2003).

The increase in the per capital vehicle ownership in the developing countries is problematic for the global environment. China's vehicle emissions, for example, have become a major source of urban air pollution world wide. In fact, China is currently the world's second-leading emitter of carbon dioxide and other greenhouse gases that contribute to global climate change. It is projected to surpass the US and become the world's top emitter by 2020 (Esty and Dunn, 1997).

India's CO_2 emissions account for only 2-4% of the world's total. But in a country rapidly expanding beyond a billion people, there are profound implications for future impact on climate change. Although per capita CO_2 emissions are low (below a quarter of the world average), the national growth rate exceeds the global rate, which leads ultimately to an increasing global share (Toman et al, 2003). Transportation accounts for 24% of India's energy use and like China's transportation system, needs improvements for environmental sustainability (Feldstein, 2006).

In some instances, there has already been a push to improve the sustainability of the environment. In India, for example, there have been some advances in the public transportation systems in order to reduce pollution in certain parts of that country. As a statement of need for these enhancements, Delhi had been one of the most polluted capitals on earth. People have been plagued with asthma and bronchitis. Improvements began in the mid 1990s after a law suit forced Delhi's taxis and buses to use a cleaner-burning compressed natural gas (CNG) as fuel (Perry, 2006). In July 1998, the Indian Supreme Court ruled in favor of this proposal and ordered a ban on leaded fuel, and conversion of all diesel-powered buses to CNG along with the scrapping of old diesel taxis. Delhi's efforts to clean its air has led to stabilization of air pollution. This has attracted international attention from numerous countries including Kenya and Indonesia where there are attempts to mimic what Delhi has accomplished regarding limitations on air pollution (Perry, 2006).

However, more needs to be done to reduce climate change and air pollution. This can be accomplished through changes in public transportation. This report will end with policy recommendations aimed at encouraging the use of and improving the infrastructure for public transportation systems in the US and in the two developing countries, China and India. These policies focus on meeting the population's commuting demands in a more environmentally sustainable way.

THE SOLUTION: POLICY RECOMMENDATIONS

It is clear that vehicle emissions present global climate and air pollution problems. One obvious way to mitigate these effects is to lower the number of cars on the road. Lowering the number of cars on the road could be accomplished through the promotion of public transportation rather than private transportation in the United States and by slowing the

growth of private transportation in the developing countries. Policy recommendations will fall

into four categories: improving public transportation systems, encouraging the use of public

transportation systems, discouraging the use of private transportation systems, and changing

urban plans and city designs. All these recommendations can be applied globally to help

transportation become more environmentally sustainable. Table 5 below outlines the main

policy recommendations; more in-depth descriptions of each recommendation will follow.

Table 5: Policy Recommendations

- Allocate more money to build new subway and bus systems and expand or improve old systems
 - Encourage citizens to use public transportation systems
     o subsidize mass transit fees for employees
     o reward carpooling
     o educate citizens to dismantle negative stigmas of public transportation
 - Discourage citizens from using personal vehicles for travel
     o increase the price of personal vehicle travel
     o reduce the number of vehicles allowed in urban areas
 - Change urban plans and city designs
     o build more walking and biking paths and bike racks

First and foremost, governments can prioritize their budgets to allocate more money in

order to build new public transportation systems and expand or improve upon old ones. For

example, in many cases there is an inadequate public transportation system linking cities to

more suburban areas. This makes the commute to work more easily accomplished through

personal vehicle transportation. In fact, Americans spend more than 100 hours per year

commuting to work. That means that in 2003, the average daily commute to work lasted 24.3

minutes (Amour, 2005). If this commute could be accomplished through subway systems and

buses, vehicle emissions would be lessoned. Once the public transportation systems are

improved, then governments can encourage citizens to use them in lieu of personal vehicle transportation.

The next step then is to encourage the use of public transportation systems. One approach would require that employers subsidize mass transit fees for their employees. This could be effective, for example, in areas with bus systems for which the employers would give bus passes to their employees. This strategy is used effectively in Portland, Oregon; Boulder, Colorado; and Santa Clara Country, California (Tumlin et al, 2003). For example, Silicon Valley companies give their employees Eco-Passes that are good for unlimited rides on the Santa Clara Valley light rail and buses. As a result, employee parking demand at these locations declined by 19% as public transit rider-ship increased (Tumlin et al, 2003).

A second policy aimed at encouraging the use of public transportation is to reward carpooling. There should be "carpool lanes" and "bus lanes" that can only be used by vehicles that are carrying more than one person. This would allow carpoolers to cut traffic in order to get to their destination. Other rewards of carpooling might include healthcare subsidies. Healthcare subsidies can be increased for employees who participate in car pool programs. For example, Children's Health care of Atlanta has doubled its monthly subsidy from $30 to $60 for the carpooling participants (Armour, 2005). Another reward of carpooling could be closer parking access. For example, in Torrance, California, Honda has reserved parking in the areas closest to its building only for car poolers. There can even be a cash incentive for carpooling. This would be based on how many days an employee carpools to work or how many people are in the car pool. Honda for example, provides cash incentives for its employees in Torrance, California who carpool, ride public transit, or bike to work. Ninety of

their total 300 employees (a rise from 70 earlier in 2005) today fall into one of these three categories (Armour, 2005).

Some employers are already taking steps to encourage their employees to commute to work using public transportation. According to a 2005 survey by the Society of Human Resource Management, about 14% of employers offer transit subsidies and 5% offer car-pooling subsidies. According to the 2000 US Census bureau, about 12% of employees carpool to work and 5% take public transportation. Working to reduce these numbers further can aid in reducing vehicle emissions.

A third policy to encourage the use of public transportation involves educating the citizens and dismantling negative stigmas that pervade society's perception of public transportation. For example, pamphlets could be administered and/or posters could be displayed around town attesting to the benefits of public transportation in an easy-to-follow and appealing manner. In addition, technologies can be put in place to make public transportation more tempting to the consumer. For example, instead of the stigmatized annoyance of late busses and broken trains, technologies could exist that display updates of when the next bus, train, or metro, etc, will arrive and the exact trip fare expected (Lee, 2000).

In addition to encouraging the use of public transportation systems, there can be programs that discourage the use of private vehicle travel. This can serve as an additional policy recommendation for making transportation more environmentally sustainable. One approach would require that the price of private vehicle travel be increased. Such an increase could include high parking fees, tolls, registration fees, gasoline taxes, and insurance fees proportional to the distance driven. If citizens had to pay more for parking, for example, they would be discouraged from driving (Tumlin et al, 2003; Uhl and Anderson, 2001). In

addition, taxing gasoline could function as a carbon tax and, in turn, address carbon dioxide emissions and the resulting climate change. Finally, payments from insurance charges that are directly proportional to vehicle miles traveled, known as the Pay as You Drive (PAYD) system, would be a deterrent to private vehicle travel and could function in a similar manner to the gas tax described above (Harrington and McConnell, 2003).

Another way to discourage the use of private vehicle travel would be to reduce the number of vehicles allowed in urban areas. Urban areas can set vehicle quotas and require permits. This would help to define the notion that having a car is a privilege, and not a right (Suess, 1993). One such quota system could involve allowing vehicles with even numbered license plates to drive in central, congested urban areas on certain days and vehicles with odd numbered plates on other days. This system works effectively today in Rome, Italy (Burtz, personal communication, May 5, 2006).

A final policy recommendation that addresses the issue of sustainability for transportation concerns urban planning and city design. For example, governments can stop allocating funds that are aimed at building car oriented roads and highways in cities. Rather, these funds can be used by the cities to build more walking and biking paths and bike racks (Tumlin, 2003). Some places, such as the National Aquarium in Baltimore, are installing bike racks to encourage employees to bike rather than drive (Armour, 2005). In urban planning, cities can be rebuilt or rezoned such that residential areas can be linked to business zones. As a result, commuting time to work would be shortened and, in turn, there would be less vehicle emissions and less unwanted environmental effects. If future urban designs allow for more compact development that combines shopping, housing, and employment, then much can be

accomplished with less travel (Harrington and McConnell, 2003). Once again, less travel means less emissions and a more sustainable environment.

CONCLUSION

It is evident that vehicle emissions are problematic to the global environment. CO_2 specifically leads to climate change and other vehicle emissions contribute to air pollution causing negative health effects for the world's inhabitants. A logical way to reduce these negative impacts would be to decrease vehicle emissions; to catch the problem before it worsens. This can be accomplished through lowering the number of vehicles on the road. The increasing trend for private vehicle ownership can be replaced by increased reliance on public transportation. Policy recommendations for reaching this goal involve improving current public transportation systems, encouraging the use of public transportation systems, discouraging the use of private vehicles, and changing urban plans and city designs.

It would be incorrect to assume that all countries will follow in the deleterious footsteps of the US regarding the transportation sector to date. Indeed, there are many geographic, social, economic, and political reasons why they should not. If the trends of the US transportation sector were replicated elsewhere, there would be even more damage to the global environment. However, in the US as well as the developing countries, China and India, the issue of vehicle emissions can be addressed by improving and promoting public transportation. However, the reality is that cars are not going to leave society's framework anytime soon. Thus, the more we can reduce their impact upon our environment and our health, the better it will be for the sustainability of all mankind (Holzman, 2005).

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